

Aug. 17, 1937.

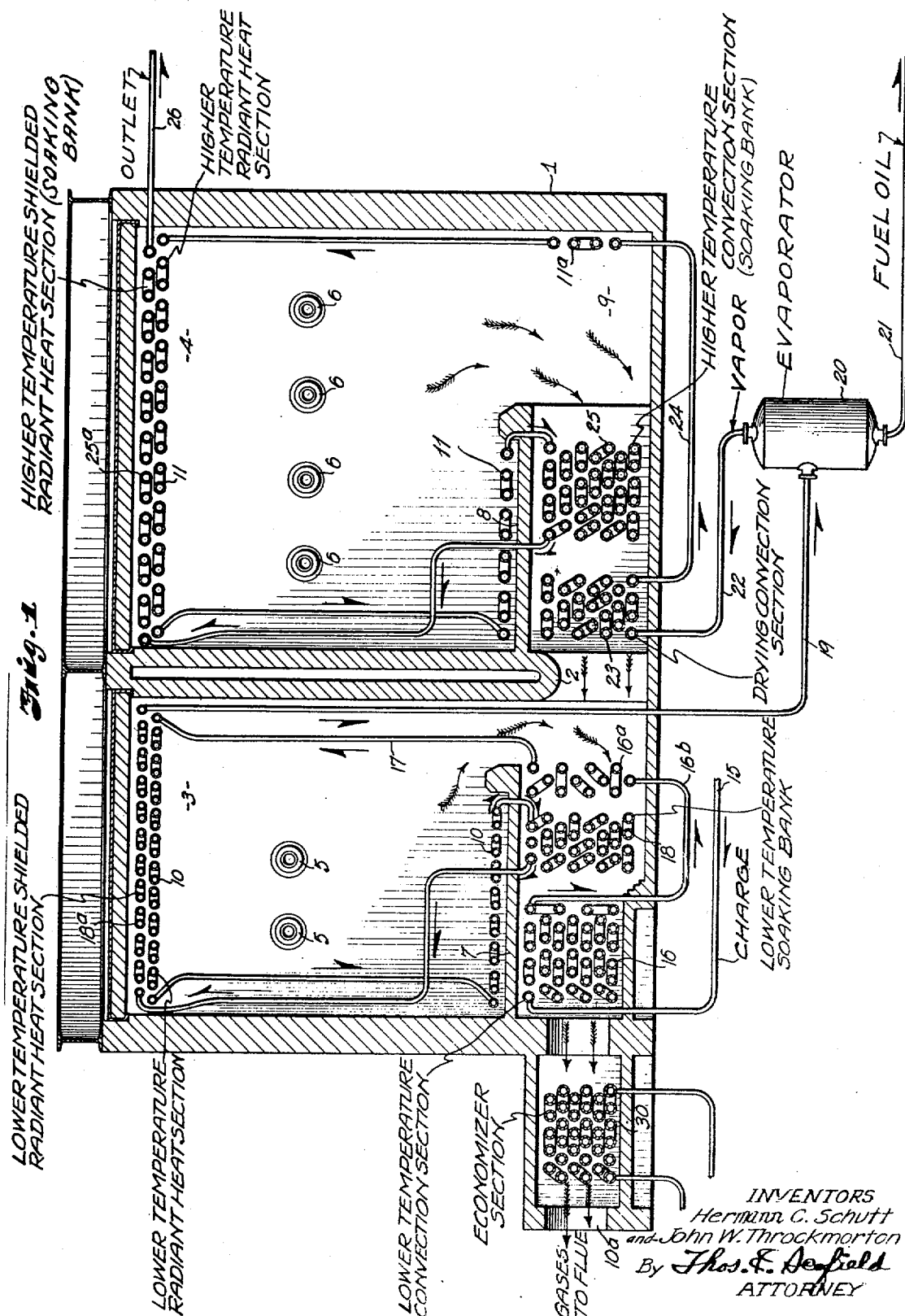
H. C. SCHUTT ET AL

2,090,504

METHOD AND APPARATUS OF HEATING HYDROCARBON OILS

Filed Oct. 9, 1933

3 Sheets-Sheet 1.



Aug. 17, 1937.

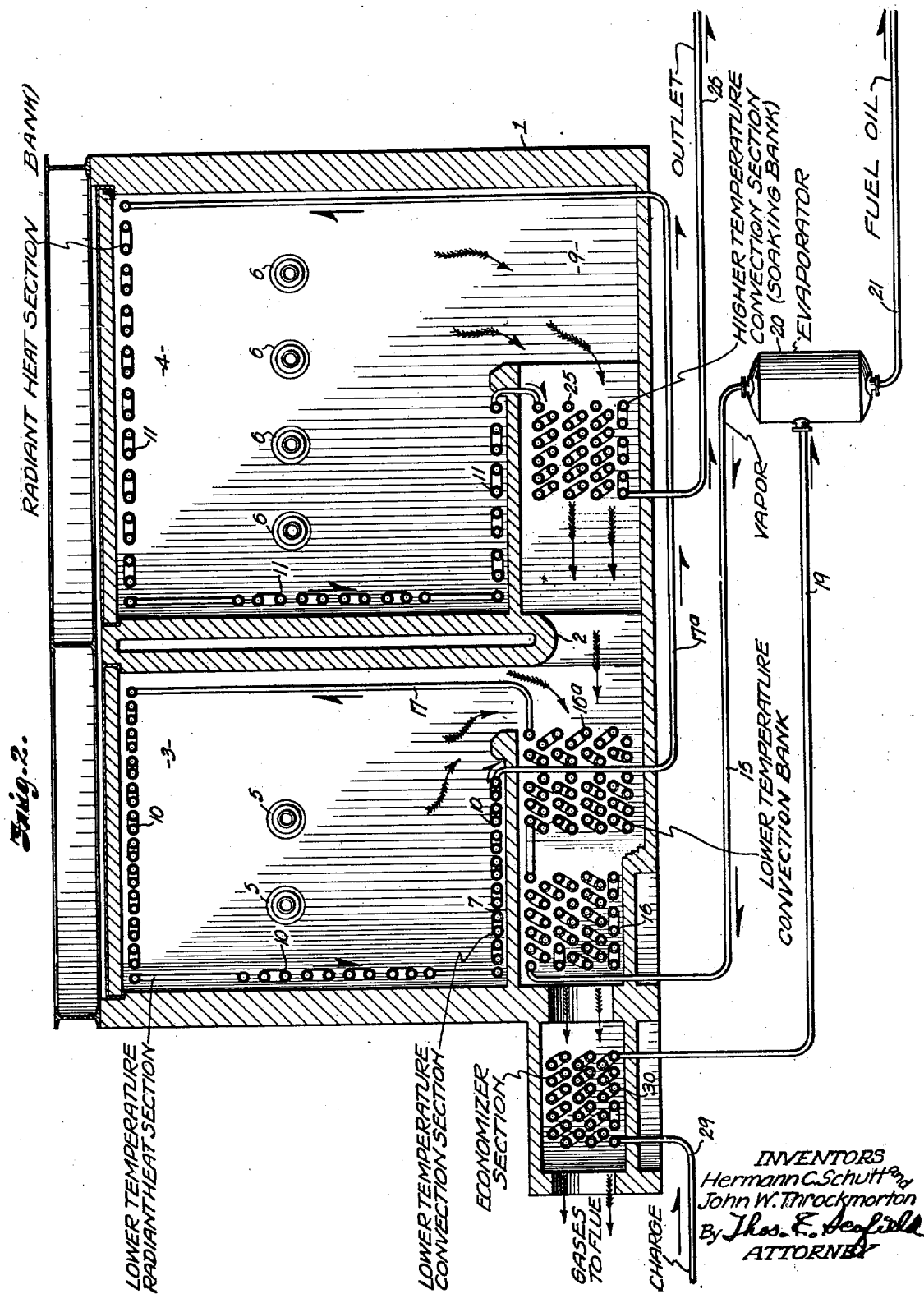
H. C. SCHUTT ET AL

2,090,504

METHOD AND APPARATUS OF HEATING HYDROCARBON OILS

Filed Oct. 9, 1933

3 Sheets-Sheet 2



Aug. 17, 1937.

H. C. SCHUTT ET AL

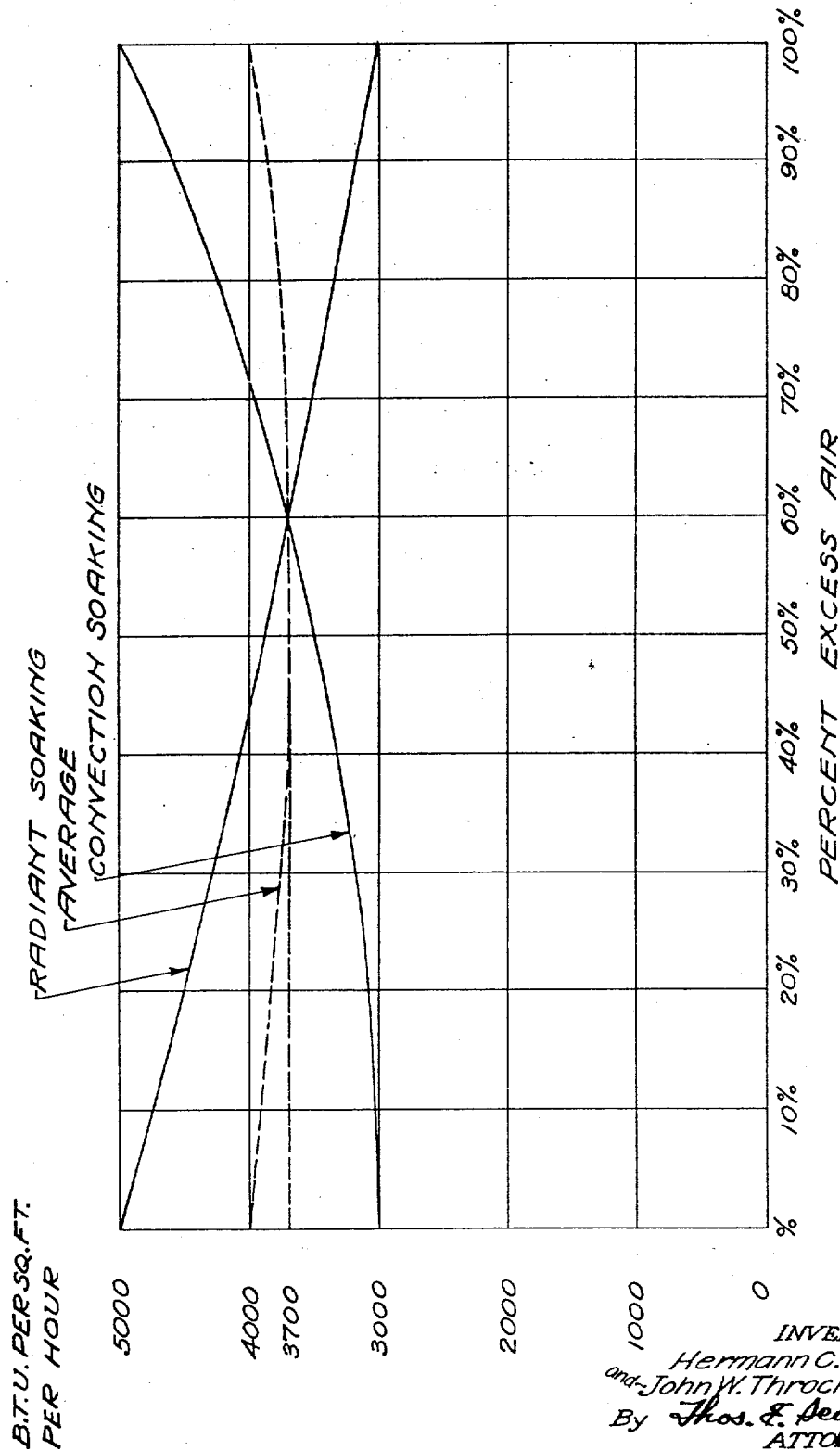
2,090,504

METHOD AND APPARATUS OF HEATING HYDROCARBON OILS

Filed Oct. 9, 1933

3 Sheets-Sheet 3

Fig. 3.



## UNITED STATES PATENT OFFICE

2,090,504

METHOD AND APPARATUS OF HEATING  
HYDROCARBON OILS

Hermann C. Schutt and John W. Throckmorton,  
New York, N. Y., assignors to Alco Products  
Incorporated, New York, N. Y., a corporation  
of Delaware

Application October 9, 1933, Serial No. 692,804

14 Claims. (Cl. 196—49)

Our invention relates to a method and apparatus for heating hydrocarbon oils, and more particularly to a furnace having sections for heating, moderate low temperature cracking and/or viscosity breaking and high temperature cracking.

In cracking operations the oil to be charged to the cracking still is either topped, heated sufficiently to reduce its viscosity and/or mildly cracked before it is passed to the cracking still in which it is subjected to high temperatures. In the Gyro process, for example, the oil to be cracked is heated to vaporizing temperatures, then flashed in a flash evaporator and the vapors subsequently cracked in the vapor phase in a high temperature coil.

It has been the practice frequently to employ separate pipe stills for different duties depending upon whether or not high temperature or low temperature heat requirements were necessary for the operation.

One object of our invention is to provide a furnace which will perform the heating functions of two stills in a novel and efficient manner.

Another object of our invention is to provide a furnace in which both higher temperature and lower temperature operations may be performed with a high efficiency.

Other and further objects of our invention will be seen from the following description.

In the accompanying drawings, which form part of the instant specification and are to be read in conjunction therewith and in which like reference numerals refer to like parts in the several views:

Figure 1 is a schematic sectional elevation of one mode of carrying out our invention.

Figure 2 is a schematic sectional elevation of another mode of carrying out our invention.

Figure 3 is a diagrammatic showing of the relationship of temperature to excess air in the embodiment shown in Figures 1 and 2.

In general, our invention comprises the provision of a furnace setting having a bridge wall defining a pair of combustion chambers. The gases of combustion from the combustion chambers are discharged at separated points into a gas passageway which may be positioned underneath or at the side of the furnace setting and enclosed therewithin. Radiant heat absorbing sections are positioned in each of the combustion chambers. A series of convection heat absorbing sections are disposed in the gas passageway, such that some are exposed only to the gases from the high temperature treating section while the remainder are exposed to a mixture of the gases issued from

the high temperature and the lower temperature treating sections. The combustion gases from the lower temperature section are discharged into the gas passageway and admixed with the combustion gases from the high temperature section having passed through the series of high temperature convection heat absorbing tubes and reached a temperature approximately the same as that of the gases escaping from the combustion chamber of the lower temperature section. The combined streams of flue gases are then passed through another section of convection tubes these being at lower temperature and positioned in that section of the gas passageway, past the point of admission of the convection gases from the lower temperature radiant heating chamber.

The hydrocarbon oil is charged first through a convection section of the lower temperature side then through a radiant heat section of the lower temperature side, then through a soaking section of the lower temperature side, then through a convection section of the higher temperature side, then through a radiant section of the higher temperature side and finally through a soaking section of the higher temperature side. Portions of the convection section or the radiant section of either side or a combination of portions of the convection section and radiant section may be used as soaking sections depending upon the purpose to be accomplished and the character of the hydrocarbon undergoing treatment. In the case of a vapor phase process, a flash evaporator is interposed between the sections of the lower temperature and the higher temperature sections. The section of the lower temperature side may then be used for viscosity breaking and the vapors from the flash evaporator may be cracked in the sections of the higher temperature side.

More particularly, referring to Figure 1, a furnace setting 1, which may be of any suitable approved construction is provided with a partition wall 2 dividing the setting into a pair of combustion chambers 3 and 4. Suitable burners 5 and 6 are positioned within the combustion chambers. Horizontal bridge walls 7 and 8 cooperate with partition wall 2, to define the combustion chambers 3 and 4. A passageway 9 is positioned within the setting 1 underneath the combustion chambers 3 and 4. If desired, this passageway may be positioned at either side. The passageway 9 terminates with an opening 10 which is connected to a stack or flue to conduct the waste gases to any suitable point, such as a smoke preventer or the atmosphere.

It will be observed that there are considerably more burners positioned in combustion chamber 4 than in combustion chamber 3. Combustion chamber 3 is in the lower temperature treating section and combustion chamber 4 is in the higher temperature treating section. Radiant heat banks 10 and 11 which may comprise roof tubes, wall tubes and/or floor tubes, are positioned within the respective combustion chambers and adapted to be heated mainly by radiant heat as can be readily observed by reference to the drawings. In the drawings, the plain arrows indicate the direction of the flow of the oil and the feathered arrows indicate the direction of the flow of the combustion gases. The hot combustion gases from combustion chamber 4 are discharged into passageway 9 and pass therethrough to the flue connection 10a. The combustion gases from combustion chamber 3 discharge into the gas passageway 9 at a separated point therein from that of the entrance of the gases from the combustion chamber 4. A series of convection tube sections are positioned within the passageway 9 as can be readily seen by reference to the drawings.

The oil to be heated is charged through line 15 through the tubes of a bank 16 of the lower temperature convection section. This section has a main bank 16 of the lower temperature convection section. This section has a main bank 16 and an auxiliary bank 16a, the purpose of which will be hereinafter more fully described. The oil from bank 16 passes through line 16b to bank 16a of the convection section, then through line 17, through the tubes of the radiant heat bank 10 of the lower temperature section, then into the tubes of the soaking bank 18 of the lower temperature convection section, and then into the tubes of the radiant soaking bank 18a of the lower temperature section. In order to guard against carbon deposition which might be occasioned by the overheating of the oil within the tubes, soaking bank 18 is positioned behind bank 16a of the lower temperature convection section and soaking bank 18a is positioned above radiant bank 10. It will be observed that bank 18 is a convection bank and that gases of combustion passing over the bank must first pass over bank 16a. In this manner, it is insured that the oil within bank 18 will not be overheated resulting in a partial decomposition with danger of carbon formation and deposition.

The oil leaves the tubes of bank 18a through line 19 and in the case of a vapor phase process, goes to flash evaporator 20 from which the unvaporized oil is withdrawn through line 21 and the oil vapors through line 22. It is to be understood, of course, that our furnace may be employed also in liquid phase cracking operations in which case the flash evaporator may be replaced by a topping tower and the cracking stock withdrawn from the topping tower may be charged through the line 22.

The oil from line 22 passes through a bank 23 of the higher temperature convection section. In this convection bank 23 which in case of a vapor phase cracking process is usually termed a drying tube section, the reactant is further heated under moderate heat transfer conditions and up to temperatures where pyrolytic reaction takes place only at a low rate. Thus the vapors are dried and all liquid particles completely vaporized under conditions which do not permit the formation and deposition of coke. The dried, or superheated, oil vapors leave bank 23 through line 24,

pass through a bank of radiant tubes 11a in which the heat absorption rate is increased but still below the rate existing in the subsequent bank of heating tubes 11, to avoid danger of carbonization of the vapors. The progressively increased heat transfer rate may be paralleled by a corresponding change in the film transfer rate of the material in the tubes, so that there would actually exist the same temperature difference between tube wall and medium in the tubes in spite of the higher heat absorption rate, thereby reducing the danger of overheating. The vapors now pass through the tubes of the radiant heating bank 11 of the higher temperature section where at a high rate of heat absorption they attain rapidly the desired reaction temperature and subsequently through the tubes of soaking convection bank 25 of this section and finally through the tubes of the shielded radiant soaking bank 25a. The oil from the shielded radiant soaking bank 25a leaves through line 26 and passes to the quenching chamber in the case of a vapor phase process, or to the reaction chamber in the case of a liquid phase process.

In operation, the oil enters the tubes of the convection banks 16 and 16a of the lower temperature section and passes through a series of radiant heating tubes 10 disposed within the combustion chamber of the lower temperature section, and then passes to the tubes of the soaking banks 18a and 18 in which the desired low temperature heat treatment is completed. In the case of a vapor phase process, for example, the vapors enter the drying tube bank 23 which is characterized by a moderate and uniform rate of convection heat absorption, and consequently low tube wall temperatures. The oil vapors then pass through bank 11a of the radiant tube section of the higher temperature section, and thence through the tubes of the radiant bank 11.

It will be observed that the vapors are heated at progressively increasing vapor film rates, avoiding high tube wall temperatures with its inherent danger of film carbonization. After these preliminary heating stages, as represented by tube banks 23 and 11a, the vapors are sufficiently super-heated that coke formation in the high transfer rate heating tubes 11 at the proper vapor film rate is unlikely. Highly superheated hydrocarbon vapors in a process of thermochemical decomposition at high temperatures will form some carbon but this carbon will be in deflocculated form, known as lamp black carbon, which will be carried away by the vapors passing through the tubes at high velocities and will not deposit on the tube walls if these are not overheated. The vapors leave the radiant heat tube section and pass into the tubes of the soaking bank 25 which is a convection bank maintained at the desired reaction temperature. The vapors leave the tubes of the convection soaking bank and pass through the tubes of the shielded radiant heat soaking bank 25a from whence they are led off through line 26 for quenching and further processing. The feature of importance in the soaking tube banks 25 and 25a is that the heat absorption rate of the soaking tubes be equal to the heat consumed by the endothermic reaction of cracking so that a uniform temperature is maintained.

The burners 5 and 6 may be oil or gas burners so that they may be readily controlled. By controlling burner 6 it is possible to obtain an adjustment which will achieve an even soaking temperature in the soaking banks 25-25a as

will be apparent by reference to Figure 3. The diagram there shown is illustrative of the manner in which the rate of heat absorption adjusts itself when a combination of radiant and convection heat absorbing soaking tubes are employed as shown in Figure 1.

The figure shows that the rate of heat absorption which is principally a function of the temperature for the radiant heat tubes, decreases in the radiant section with an increase in the amount of air in excess of that required for complete combustion. This is due to the lowered mean temperature in the radiant section. At the same time, however, the excess air causes an increase in the flue gas velocity with a resultant more efficient transfer of heat from the flue gas to the convection heat tubes and a consequent rise in the rate of heat absorption. Obviously, therefore, a furnace designed with a soaking bank formed by a second row of roof tubes and another soaking section formed as a convection bank may be efficiently operated according to the requirements of the particular charging stock and its characteristics as far as the reaction rate is concerned. Figure 3 shows that with a rate of heat absorption of around 3700 B. t. u./sq. ft./hr. in the radiant and convection soaking sections, substantially 60% excess air is required. As more or less air is supplied, the rate of heat absorption in the radiant and convection sections changes in a manner which is clearly shown in the diagram of Figure 3. It is thus clear that considerable variation in the operating conditions for the radiant and convection soaking tube sections can be had by a regulation of the amount of excess air.

The flue gases emanating from the high temperature section are ordinarily not tempered by the gases escaping from the low temperature radiant section. The latter may be as high in temperature as the former. However, in such cases where extreme high temperature treatment is performed in the high temperature section, and the flue gas temperature of the combustion gases leaving this section is still so high that a high heat absorption rate is forced on the front rows of tubes in the lower temperature convection section, and the material in these tubes (liquid oil in most cases) will carbonize at the overheated tube wall, then the combustion in the lower temperature radiant section can be so adjusted that the flue gases leaving this combustion chamber will be of lower temperature and actually temper the combustion gases leaving the higher temperature section. It will be observed that the hot gases from combustion chamber 4 are cooled by passing through the soaking bank 25 and the drying bank 23. They will in some cases, however, still be too hot for the convection tubes of the lower temperature section of the furnace. Before they are allowed to contact the convection banks of the lower temperature section, the combustion gases from the lower temperature section are admixed therewith. The temperature of the flue gas mixture can be readily controlled by the firing conditions of burners 5 determining the temperature of the flue gases leaving the combustion chambers of the lower temperature section. Adjustments can be made so that the resulting gases passing through the convection section of the lower temperature section will be at that temperature desired for the process being conducted.

It will be observed that our arrangement makes for a very flexible design, in that the duties of

the two sections may be varied at will without impairing the performance of either individual section. A maximum of economy is thus obtained and uniform results achieved in a process involving a multitude of separate phases of operation. An economizer tube bank 30 may be positioned in the gas passage before the gases go to the flue to effect the highest possible furnace economy. The section may be used to heat a circulating medium for use in evaporators, heaters, reboilers, or for the generation of steam.

As an example of the operation of our furnace, the topped crude, gas oil or a mixture of gas oil, a relatively heavier oil at a temperature between 550° F. and 600° F. is charged through line 15, to the convection preheating banks 16—16a where the oil is heated to around 700° F. The heated oil from bank 16a is raised in the radiant heated tubes of combustion chamber 3 to a temperature ranging between 850 and 800° F. which is maintained in the convection heated and radiant heated soaking banks 18—18a. The heated oil from the moderate low temperature cracking or viscosity breaking section of the furnace is then charged through the line 19 to the evaporator 20 from which the oil vapors at a temperature of approximately 800° F. are led through the convection drying section 23 where the temperature is raised to 850° F. The dried oil vapors are then passed through the radiant heated bank 11a where the temperature is raised to 875–900° F. before the final heating of the oil vapors takes place in radiant heated banks 11 where the temperature is raised to 1100–1300° F. The final pyrolytic treatment or high temperature cracking takes place in the soaking sections 25—25a where the oil vapors still at a temperature of between 1100–1300° F. are subjected to the final cracking. The flue gases leave combustion chamber 4 at a temperature between 1700° to 1800° F. and are cooled by passage through the convection banks 25 and 23 to a temperature of about 1300° F. The combustion gases from the low temperature treating section 3 leave at a temperature between 1100–1300° F. and are commingled with the gas from the high temperature treating or cracking section such that the resultant temperature of the commingled gases prior to passage through the convection banks 16a, 18 and 16 is between 1250–1300° F. The gases in passing through the convection banks 16a, 18 and 16 are reduced in temperature to between 800°–900° F. A further reduction in temperature is effected as the result of the passage of the gases through the economizer bank 30 wherein the temperature falls to around 600° F. before passage into the stack. It is to be observed, that the economizer bank 30 may be used to heat a charging stock which may be raised from 300° F. to 690° F. by passage therethrough. The heated stock could then be flashed into an evaporator tower from which the vapors could be withdrawn at a temperature between 550°–600° F. and charged to the convection preheating bank 16 as before.

Referring now more particularly to Figure 2, a modification is disclosed in which one section of the furnace is used for preliminary drying and heating to the desired cracking temperature and the other is used for soaking.

Oil is charged through the line 29 to the economizer bank 30 where the temperature is raised by convection heat and the heated oil then led by line 19 to the evaporator 20. The vapors separated in the evaporator 20 are charged through

the line 15 to a preliminary drying bank formed by convection heated sections 16—16a from which the vapors are led by the line 17 to the radiant heat bank 10 in the combustion chamber 3 which may comprise roof, floor and wall tubes in which the vapors are rapidly brought up to the desired cracking temperature. The heated vapors are led by a line 17a to the radiantly heated bank 11 in the combustion chamber 4 where the final pyrolytic reaction takes place. The radiant soaking bank 11 is supplemented by a convection heated soaking bank 25 positioned in the passageway 9 and from which the vapors are led by line 26 for further processing or cooling. In the event that it is desired to utilize the furnace for liquid phase cracking, a distillate or a topped crude from a topping tower may be charged through the economizer bank 30 and then led directly into the convection preheating banks 16—16a from which the oil is led for heating as in the vapor phase operation.

It is to be observed that our furnace permits of separate control of the temperatures in the radiant heating and soaking sections by the firing of the burners 5 and 6 located respectively in the chambers 3 and 4. Extreme flexibility of control of the cracking temperatures is thus provided and forms an important feature of our invention.

The diagram of Figure 3 is particularly applicable to the furnace of Figure 2. A proper control of the excess air in the combustion chamber 4 will permit of considerable variation in the rate of heat transfer to the radiant heated and to the convection heated tubes of the soaking section independently of the temperature in the cracking section 3.

It is to be further observed that this modification is illustrative of a type of operation in which the gases from the extreme high temperature soaking section are tempered and cooled by the cooler gases from the combustion chamber 3 before they are allowed to contact the convection heated section 16—16a. The formation of and deposition of carbon within the tubes of these sections as the result of too rapid heating is thus prevented.

For example, assuming a naphtha reforming operation, the reactant after initial heat exchange is charged through the economizer bank 30 and is raised in temperature from 250° to 650° F. and then passed to the evaporator 20 through the line 19. The vapors from the evaporator at a temperature of between 550—600° F. are heated in the convection sections 16—16a of the lower temperature section, to approximately 800—900° F. before entrance into the radiant heated bank 10 of the heating section 3. The vapors are rapidly heated in the tubes 10 to a temperature between 1100—1300° F. for high temperature cracking and then passed to the soaking banks 11 and 25 of the higher temperature section where the final reaction takes place.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of our claims. It is further obvious that various changes may be made in details within the scope of our claims without departing from the spirit of our invention. It is, therefore, to be understood that our invention is not to be limited to the specific details shown and described.

Having thus described our invention, what we claim is:

1. The method of heating hydrocarbon oils comprising the steps of simultaneously burning fuel in a pair of combustion chambers, absorbing in zones of the combustion chambers heated mainly by radiant heat portions of the respective radiant heats of combustion by hydrocarbon oil being circulated in confined streams through said combustion chambers, absorbing in a zone heated mainly by convection heat part of the convection heat of the gases of combustion issuing from one of said combustion chambers by hydrocarbon oil passing to said combustion chamber in a confined stream, whereby to reduce the temperature of said gases, commingling said gases thus reduced in temperature with the gases of combustion issuing from the other of said combustion chambers and absorbing in a zone heated mainly by convection heat part of the convection heat from the resulting mixture of combustion gases by hydrocarbon oil passing in a confined stream to said last mentioned combustion chamber.

2. A furnace for heating hydrocarbon oils comprising in combination, a unitary setting, a vertical partition wall and a pair of horizontal bridge walls within said setting defining therewith a pair of combustion chambers, means for burning fuel disposed in each of said chambers, oil circulating means positioned in each of said chambers adapted to be heated mainly by the radiant heat of combustion, oil circulating means adapted to be heated mainly by convection heat from the gases of combustion issuing from only one of said chambers and connected to the oil circulating means in said one of said chambers, and separate oil circulating means adapted to be heated mainly by convection heat from the combined combustion gases from both of said chambers connected to the oil circulating means in the other of said chambers.

3. A furnace as in claim 2 wherein said respective oil circulating means are connected in series.

4. A furnace for heating hydrocarbon oils comprising in combination a setting, a partition wall within said setting, defining a pair of combustion chambers, means for burning fuel disposed in each of said chambers, a gas passage, means for discharging combustion gases from said chambers into said passage at separated points therealong, a pair of tube banks positioned in said passage adapted to be heated mainly by convection heat of the gases from one of said chambers, a pair of tube banks positioned in said passage adapted to be heated by convection heat of the gases from both of said chambers, respective tube banks adapted to be heated mainly by radiant heat positioned in said chambers, and means for passing hydrocarbon oil through one of the banks of said last mentioned pair of convection tube banks, then through a radiant tube bank, then through the other bank of the said last mentioned pair of convection tube banks, then through a convection tube bank of said first mentioned pair of convection tube banks, then through the other of said respective radiant tube banks and then through the remaining convection tube bank.

5. Heating hydrocarbon oil by passing it through tube banks and heating it in succession as follows: heating the oil mainly by convection heat; heating the oil mainly by radiant heat; heating the oil mainly by a second convection heat; heating the oil mainly by shielded radiant heat; heating the oil mainly by convection heat

of higher temperature than said first convection heat; heating the oil mainly by radiant heat of higher temperature than said first radiant heat; heating the oil mainly by convection heat of higher temperature than said second convection heat; heating the oil mainly by shielded radiant heat, of higher temperature than said first shielded radiant heat.

6. A process of heating hydrocarbon oil comprising the steps of progressively passing it in an elongated, confined stream through a first coil of a pair of serially connected coils disposed in a gas passage, through an intermediate coil disposed in a gas generating zone, and through the second coil of the pair, generating hot gases of combustion in a first gas generating zone, subjecting the oil stream in the second coil of the pair to the convection heating action of said gases, independently and simultaneously generating further hot gases of combustion in a second gas generating zone, effecting absorption by the oil during passage of the stream through the intermediate coil of part of the radiant heat of combustion of the hot gases generated in said second zone, after the stream has passed through the first of said pair of serially connected coils and before it has passed through the second of said pair of coils, and introducing the combustion gases generated in said second gas generating zone into said gas passage between said coils.

7. A process of heating hydrocarbon oil comprising the steps of passing it in an elongated, confined stream through a series of heating zones and heating it in succession in a convection heating zone, in a radiant heating zone of one temperature, in a radiant heating zone of a higher temperature, and in a convection heating zone of a higher temperature than said first convection heating zone, generating hot gases of combustion in a first gas generating zone, generating hot gases of combustion in a second gas generating zone, said first convection heating step being performed by the hot gases of combustion from both gas generating zones, said first radiant heating step being performed only by the radiant heat of combustion in said first gas generating zone, said second radiant heating step being performed by the radiant heat of combustion in said second gas generating zone, and said second convection heating step being performed by the hot gases of combustion from said second gas generating zone only.

8. A process of heating hydrocarbon oil comprising the steps of passing oil in an elongated, confined stream in a series of heating zones and heating the oil in succession in a convection heating zone, in a radiant heating zone, in a second convection heating zone, in a third convection heating zone, in a second radiant heating zone, and in a fourth convection heating zone, generating hot gases of combustion in a first gas generating zone, generating hot gases of combustion in a second gas generating zone, said first radiant heating step being performed by the radiant heat of combustion in said first gas generating zone, said second radiant heating step being performed by the hot gases of combustion in said second gas generating zone, said first and second convection heating steps being performed by the hot gases of combustion from both said gas generating zones, and said third and fourth convection heating steps being performed by the hot gases of combustion from one of said gas generating zones.

9. A process of heating hydrocarbon oils comprising the steps of burning fuel in a first com-

bustion zone to generate radiant heat and hot gases of combustion, independently burning fuel in a second lower temperature combustion zone to generate radiant heat and hot gases of combustion, separately withdrawing the hot gases from each combustion zone, tempering the gases withdrawn from the first combustion zone by commingling them with the cooler gases withdrawn from the second combustion zone, simultaneously passing hydrocarbon oil in an elongated confined stream through the zone containing the tempered commingled gases to thereby heat the oil mainly by the convection heat of the gases and then passing the oil in a confined stream through the combustion zones of successively higher temperature to thereby progressively heat the oil mainly by the radiant heat generated in each.

10. A process of heating hydrocarbon oils comprising the steps of passing the oil in heat interchange relationship with hot gases in a convection heat absorption zone, simultaneously converting energy in a second heating zone to cause radiant heat and the formation of hot gases, withdrawing the hot gases from the second heating zone and passing them through the convection heat absorption zone, passing the oil in a confined stream through the second heating zone and heating the oil mainly by radiant heat, separately and independently converting energy in a third higher temperature heating zone to cause radiant heat and the formation of hot gases, passing the oil from the second heating zone through the third heating zone and absorbing a portion of the radiant heat therein, withdrawing the hot gases from the last mentioned zone cooling said gases to substantially the temperature of the gases issuing from said second heating zone and then commingling the cooled gases with the hot gases issuing from the second heating zone.

11. A process of converting hydrocarbon oils into hydrocarbon oils of lower molecular weight comprising the steps of independently generating hot gases of combustion in a first combustion zone and in a second combustion zone, withdrawing the gases from each of said zones, passing the gases from the second zone in heat exchange relationship with cooler hydrocarbon oil, commingling the cooled gases with the gases withdrawn from the first zone, passing hydrocarbon oil to be converted in heat exchange relationship with the commingled gases to effect a first gradual temperature rise in the oil, passing the then heated oil in heat exchange relationship with the radiant heat in the first combustion zone to secure a second rapid temperature rise in the oil and a mild cracking reaction, passing the partially cracked oil in heat exchange relationship with the gases issuing from the second combustion zone to effect the cooling of said gases and a further gradual temperature rise in the oil and then passing the oil in heat exchange relationship with the radiant heat in the second combustion zone to raise the oil to the final cracking temperature.

12. A process of converting hydrocarbon oil comprising independently generating hot gases of combustion and radiant heat in separate combustion zones, separately withdrawing and then combining the gases from each zone, passing hydrocarbon oil to be cracked in heat exchange relationship with the combined gases as a preliminary heating step, subjecting the heated oil to a viscosity breaking reaction by passing it in heat exchange relationship with the radiant heat

in one of said combustion zones, separating the vaporized from the unvaporized oil, passing the vapors in heat exchange relationship with the gases issuing from the other of said combustion zones whereby the gases are cooled before being commingled with the gases issuing from the other zone, and the vapors are dried, and raising the dried vapors to the desired cracking temperature by passing them in heat exchange relationship with the radiant heat generated in said last mentioned combustion zone.

13. A process of converting hydrocarbon oils comprising the steps of independently generating both hot gases of combustion and radiant heat in separate cracking and soaking zones, separately withdrawing the gases of combustion from each of said zones, combining the gases, passing hydrocarbon oil to be cracked in heat exchange relationship with the combined gases whereby the oil is initially heated, subjecting the heated oil to heat exchange with radiant heat in said cracking zone to effect a rapid temperature rise to a predetermined cracking temperature, passing the oil at the cracking temperature to the soaking zone and there subjecting it to radiant heat for a predetermined time interval sufficient to effect a substantial cracking of the oil, then passing the oil in convective heat exchange relationship with the hot gases issuing from the soaking zone to

effect a cooling of said gases, and withdrawing the cracked oil from the process.

14. A tube still for converting hydrocarbon oils comprising in combination, a furnace setting, a partition wall within said setting defining therewith a pair of combustion chambers, a bridge wall in each chamber, said bridge walls defining with said setting a passageway for the combustion gases issuing from both of said chambers, means for burning fuel disposed in a portion of each of said chambers, a tube bank positioned in said passageway and adapted to be heated mainly by convection heat of the gases from one of said chambers, a pair of tube banks positioned in said passageway and adapted to be heated mainly by convection heat of the gases from both of said chambers, one of the banks of said pair serving as a hottest gas shield for the other, tube banks adapted to be heated mainly by radiant heat positioned in said chambers, and means for passing hydrocarbon oil through the shielded bank of said pair of convection heated tube banks, then through the shield bank of said pair, then through a radiant heated tube bank in one of said chambers, then through a radiant heated tube bank in the other of said chambers, and then through the first mentioned convection heated tube bank.

JOHN W. THROCKMORTON.  
HERMANN C. SCHUTT.

### DISCLAIMER

2,090,504.—*Hermann C. Schutt and John W. Throckmorton*, New York, N. Y. METHOD AND APPARATUS OF HEATING HYDROCARBON OILS. Patent dated August 17, 1937. Disclaimer filed December 30, 1939, by the assignee, *American Locomotive Company*.

Hereby enters this disclaimer to claim 9 of said Letters Patent.  
[Official Gazette January 30, 1940.]

in one of said combustion zones, separating the vaporized from the unvaporized oil, passing the vapors in heat exchange relationship with the gases issuing from the other of said combustion zones whereby the gases are cooled before being commingled with the gases issuing from the other zone, and the vapors are dried, and raising the dried vapors to the desired cracking temperature by passing them in heat exchange relationship with the radiant heat generated in said last mentioned combustion zone.

13. A process of converting hydrocarbon oils comprising the steps of independently generating both hot gases of combustion and radiant heat in separate cracking and soaking zones, separately withdrawing the gases of combustion from each of said zones, combining the gases, passing hydrocarbon oil to be cracked in heat exchange relationship with the combined gases whereby the oil is initially heated, subjecting the heated oil to heat exchange with radiant heat in said cracking zone to effect a rapid temperature rise to a predetermined cracking temperature, passing the oil at the cracking temperature to the soaking zone and there subjecting it to radiant heat for a predetermined time interval sufficient to effect a substantial cracking of the oil, then passing the oil in convective heat exchange relationship with the hot gases issuing from the soaking zone to

effect a cooling of said gases, and withdrawing the cracked oil from the process.

14. A tube still for converting hydrocarbon oils comprising in combination, a furnace setting, a partition wall within said setting defining therewith a pair of combustion chambers, a bridge wall in each chamber, said bridge walls defining with said setting a passageway for the combustion gases issuing from both of said chambers, means for burning fuel disposed in a portion of each of said chambers, a tube bank positioned in said passageway and adapted to be heated mainly by convection heat of the gases from one of said chambers, a pair of tube banks positioned in said passageway and adapted to be heated mainly by convection heat of the gases from both of said chambers, one of the banks of said pair serving as a hottest gas shield for the other, tube banks adapted to be heated mainly by radiant heat positioned in said chambers, and means for passing hydrocarbon oil through the shielded bank of said pair of convection heated tube banks, then through the shield bank of said pair, then through a radiant heated tube bank in one of said chambers, then through a radiant heated tube bank in the other of said chambers, and then through the first mentioned convection heated tube bank.

JOHN W. THROCKMORTON.  
HERMANN C. SCHUTT.

### DISCLAIMER

2,090,504.—*Hermann C. Schutt and John W. Throckmorton*, New York, N. Y. METHOD AND APPARATUS OF HEATING HYDROCARBON OILS. Patent dated August 17, 1937. Disclaimer filed December 30, 1939, by the assignee, *American Locomotive Company*.

Hereby enters this disclaimer to claim 9 of said Letters Patent.  
[Official Gazette January 30, 1940.]